Missouri Department of Natural Resources

Break It Down! The Compost Connection
Grades 4 to 8 / Video Supplement

Waste Management Program fact sheet 9/2007

Recycled Paper

PUB0697

How To Use This Guide

The video, *Break it Down! The Compost Connection*, examines how composting fits into the issue of solid waste management. The video explains that composting takes advantage of the natural process of decomposition and the potential for using composting to reduce the volume of materials being disposed of in landfills. The video also will provide information pertaining to the beneficial uses of composting.

Break It Down! The Compost Connection targets students in grades four through eight. While the video may be used as a stand alone teaching aid, it is suggested that it be a part of a unit covering the subject of composting or solid waste management. The video is divided into segments that discuss different aspects of composting. Each segment may include one or more topics related to composting. Segments are recognized by distinct breaks in the video that have an on-screen title accompanied by a short musical clip.

The guide provides background information for each segment in the order in which it occurs in the video. Along with suggested classroom activities, the guide provides a list of vocabulary words and additional reference materials.

Table of Contents

Introduction……..……2

Compost: Humus, Microbes and You…….3

Compost Critters……..…5

Life in the Trenches…….....7
Mulching Mower, Worm Farmers,
The Big Breakdown, Tree-Cycling……..……...7

Poultry in Motion, Sawdust Solutions,
A Fishy Situation……8

Kids and Compost……...…9

Classroom Activity……..9

Compost Tower Assembly Instructions……11

Vocabulary…….……...14

References…….……14

Author: Dennis Hansen - Missouri Department of Natural Resources
Photos: Nick Decker - Missouri Department of Natural Resources
Graphic design: Renee Bungart - Missouri Department of Natural Resources
Web Video: Van Beydler - Missouri Department of Natural Resources

Introduction

The management of solid waste is an important environmental concern for Missouri. The major challenge is dealing with increasing amounts of refuse generated that requires disposal into an ever decreasing space. To address this concern, Missouri has set a solid waste reduction goal. The goal is to reduce the amount of waste going into Missouri's landfills 40 percent by weight. The state is trying to reduce the volume of waste going into landfills by taking things out that can be recycled before it gets put into the trash...such as paper, plastic, aluminum and glass. Another way to recycle is called composting. Composting recycles the organic materials in yard waste that include leaves, grass clippings and unwanted vegetation from gardening. In 1992, it became illegal for Missouri landfills to accept yard wastes, garden waste and Christmas trees. As a result of this ban, composting of organic materials is becoming an accepted method of waste reduction.

Composting of organic materials is becoming an accepted method of waste reduction.

Compost: Humus, Microbes and You

Major Topics:

1. Historical Background -Sir Albert Howard
2. General Rules of Composting
3. The Nutrient Cycle
4. Essential Elements

Sir Albert Howard

Sir Albert Howard was a British government ***agronomist*** who spent 1905 to 1934 in India. While in India, Howard experimented with the process of making compost. Through his experimentation, Howard devised a composting technique referred to as the Indore Method (in reference to the Indore, India, region). The method uses a layering process that essentially sandwiches different types of organic materials within a compost pile. Howard's studies are the basis for much of what is now taken for granted concerning composting processes.

General Rules of Composting

Rule #1 Almost anything that was ever alive can be composted. A proper mix of compostable materials is necessary to create a pile that will function chemically. The proper mix, known as the carbon to nitrogen (C:N) ratio, aids in breaking down the nutrients locked up in the remains of the living organisms. The nutrients are then recycled into the environment.

Rule #2 People don't create compost. They provide the materials in the right proportions for microorganisms to break the materials down. For the microorganisms to break down the materials, there are four essential ingredients: an energy source, a protein source, moisture and oxygen. The four essential ingredients necessary for a successful compost pile are;

1. **Carbon** - Energy Source -Browns
2. **Nitrogen** - Protein Source -Greens
3. **Water** - Moisture
4. **Oxygen** - Turning the materials aerates the pile and provides oxygen

The Nutrient Cycle

Composting and the process of ***decomposition*** play an important role in the nutrient cycle. In essence, the nutrient cycle is the course traced by any particular life-essential substance as it moves through the physical and biological environment. The nutrient cycle is a basic concept in ecology. Essential nutrient cycles include those of carbon, nitrogen, oxygen and water. Many other elements and compounds also are essential, even if only in trace amounts. Two elements that play important roles in composting are carbon and nitrogen.

Essential Elements

Carbon Cycle

Carbon, used by all living organisms, continuously circulates in the earth's ***ecosystem***. In the atmosphere, it exists as colorless, odorless carbon dioxide gas, which is used by plants in the process of ***photosynthesis***. Animals acquire the carbon stored in plant tissue when they eat and release carbon as they exhale carbon dioxide, a by-product of metabolism. Although some carbon is re- moved from circulation temporarily as coal, petroleum, fossil fuels, gas and limestone deposits, ***respiration*** and photosynthesis balance to keep the amount of atmospheric carbon relatively stable. Industrialization, however, has contributed additional carbon dioxide to the environment.

Nitrogen Cycle

Nitrogen is a component of all ***proteins*** and ***amino acids***. The atmosphere is the largest nitrogen reservoir. Gaseous nitrogen (N2) makes up about 78 percent of the atmosphere. However, the bonds that hold N2 together are very strong. Consequently few organisms can break the bonds. Only certain bacteria, lightning and volcanic action can naturally convert N2 into forms that can enter food webs.

Nitrogen is often the scarcest of all nutrients required for plant growth. Nearly all of the nitrogen in soils has been put there by nitrogen-fixing organisms. Through decomposition, bacteria and fungi break down nitrogen-containing materials such as animal waste and remains of dead organisms in the ecosystem. The decomposers use a portion of the released nitrogen from proteins and amino acids for their own metabolism. Most of the nitrogen is still in the decaying materials in the form of ammonia or ammonium, which can be taken up by plants.

Carbon to Nitrogen Ratio (C:N)

Some understanding of the concept of the carbon to nitrogen (C:N) ratio is necessary to create the right mix of ingredients in a compost pile. Organisms found in the compost file require substances that contain carbon rings. Carbon-ring molecules are structures that have carbon molecules linked together in the shape of a ring. The organisms also require nitrogen found in proteins and amino acids. Breaking the carbon linkages releases energy, and nitrogen is used for manufacturing protein.

The two elements, carbon and nitrogen, are used by microorganisms in a proportion that averages about 30 parts carbon to 1 part nitrogen or a 30:1 ratio. The microorganisms convert organic material most efficiently when provided with materials having about a 30:1 carbon to nitrogen ratio. Most compostable materials do not fit the 30:1 ratio. Fresh grass clippings, also known as greens, have a C:N ratio of 20:1, too much nitrogen. Brown material such as dry tree leaves have too little nitrogen with a C:N ratio of 40:1. When browns and greens are mixed together so that the C:N ratio is closer to 30:1, faster decomposition will occur.

Compost Critters

Major Topics:

1. Compost Pile Ecosystem

2. Life in the Compost Pile

Compost Pile Ecosystem

Compost piles are a great deal more than what they appear to be. Not only is a com- post pile full of organic materials that were once living, it is also full of living organisms. Organisms that aid in decomposition may be separated into two groups, microorganisms and macroorganisms. Microorganisms are too small to see without the help of magnifying instruments. Macro-organisms can be seen readily with the unaided eye. Together, the organisms work to break down organic materials. Through this breakdown, vital elements tied up in organic materials are released and made available to plants in a usable form. The process of decomposition keeps a constant flow of nutrients going to plants.

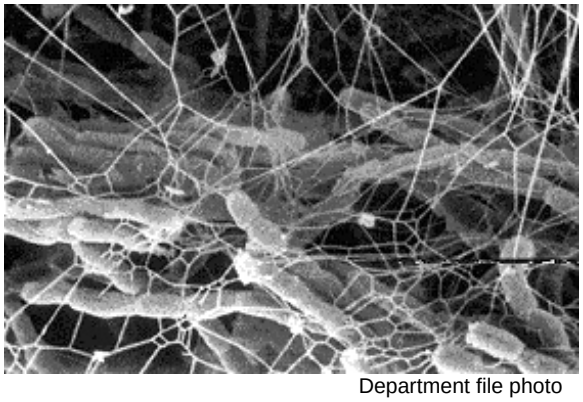
Microorganisms that play an active role in the composting process include bacteria, ***fungi*** and actinomycetes (another type of bacteria). Bacteria found in compost metabolize or break down the raw organic material and use it as an energy source. Fungi and actinomycetes clean up what the bacteria have left behind. They decompose the toughest things to break down such as starches, cellulose, lignin and proteins.

As mentioned earlier, macroorganisms also aid in the decomposition of organic materials. These organisms include insects, grubs, nematodes, mites and earthworms. The chewing, eating, digesting and digging activities of these organisms increase the surface area of the organic materials, which in turn makes it easier for bacteria and other microorganisms to metabolize.

All of these organisms assist in breaking down organic matter in the compost pile. During this breakdown process, elements and minerals are slowly released into the system. After the nutrient rich, finished compost or ***humus*** is mixed into garden soil, these nutrients are then absorbed by plants and help them to grow.

Life in the Compost Pile

1. **Bacteria** - These single-celled organisms have immeasurable ecological impact. The billions of bacteria cells in nearly every square meter of soil, water and air release oxygen into the atmosphere and recycle carbon, nitrogen and other elements. These organisms consume enormous quantities of dead animals, fungi and plant matter that would otherwise poison the environment. The beneficial role of bacteria in the environment cannot be overstated.



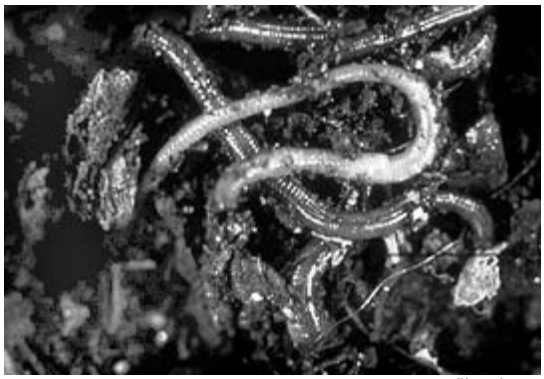
Department file photo

2. **Actlnomycetes -** These tiny bacteria were once classified as fungi because they closely resemble them in appearance. They are a very important group of bacteria as we derive most of our antibiotics from members of actinomycetes. Because actinomycetes produce antibiotics, other types of bacteria are reduced in number in the compost pile when actinomycetes are found in high numbers. Some actinomycetes also have the ability to convert nitrogen gas (N2), a form of nitrogen that plants cannot use directly as a nutrient, into ammonia (NH3), a more useful form.

3. **Protozoans -** Protozoans are single-celled organisms and are able to move about freely. A distinguishing difference between protozoans and bacteria is that protozoans have a *cell nucleus* while bacteria do not. Protozoans are dependent on a watery environment. Those that are land dwelling live in soil water or in wet leaf litter, wood and similar damp places. A moist compost pile is a perfect environment for protozoans. Protozoans are able to ingest their food and play an active role in breaking down organic material in the compost pile.

4. **Sow Bugs -** These animals belong in the same class of organisms as crayfish and lobsters, *Class Crustacea.* Sowbugs occur chiefly in humid areas such as in and around rotting logs, under stones or in the soil.

5. **Earthworms -** Charles Darwin, the great English naturalist, suggested that all of the fertile areas on earth have passed through the bodies of earthworms at least one time. The earthworms ingest and digest the organic matter. As an earthworm passes organic materials through its body, the organic material is ground up with the help



Department file photo

of tiny stones in the earthworms gizzard. The material exits the earthworm's body in the form of castings. The castings are rich in nutrients that can be readily absorbed by plants. Earthworms may produce as much as their own weight in castings each day. Earthworms thrive on compost. Compost quality is enhanced both physically and chemically through the actions of earthworms.

Earthworms also appear to have some- what of a symbiotic relationship with bacteria. The digestion process of earthworms assists bacteria in digesting organic materials while bacteria aid in earthworms' digestive process. The bacteria also are digested in the gut of the earthworm. A bacterium is about sixty percent protein, a highly nutritious food for earthworms.

6. **Slugs -** Slugs are mollusks, related to snails and octopi. The food that slugs search out in the compost pile is fresh garbage, such as vegetable waste from the kitchen, and plant debris. While slugs aid in the breakdown of organic material, they also can cause a problem in your garden by damaging your crops. You should look for slugs before spreading finished compost on the garden.

Life in the Trenches

The natural process of decomposition can be used for many different composting applications.

Mulching Mower

Mulching mowers have become quite popular in recent years. Mulching mowers are designed differently from conventional mowers. They are equipped with closed trap doors that prevent a discharge point. The second difference is they have a higher horsepower rating, because mulching mowers require more power to cut and re-cut the grass. The third difference is a special blade. The special blade not only cuts, but it also acts as a vacuum and fan that circulates the clippings back to the blade for additional pulverizing.

Mowing with a mulching mower requires that the lawn not be overly wet and has not been left too long between cuttings. The lawn is best cut when the grass is one third higher than the height of the blade. The lawn must be mowed more often than with conventional mowers. Mulching mowers should be used every five to six days instead of every week.

Worm Farmers

The students at Two- Mile Prairie School keep worms in their classroom to eat food wastes. Breaking down vegetable food waste with the help of worms is known as vermicomposting. Worms can compost food scraps faster than any other type of composting method. Earthworms are capable of consuming their entire weight in soil and organic matter every day. In the course of their eating and consequent digestive processes, earthworms leave behind the richest and most productive compost known.

The waste products from earthworm digestion are called castings. When earthworm castings are confined within a worm bin, the resulting composted material is referred to as vermicompost. Keeping a worm bin at home, school or work is an effective way of reducing the amount of waste entering the landfill.

Department photo by Nick Decker

The Big Breakdown

Composting yard wastes in large volume is often the best alternative for cities and towns. Municipal composting involves the formation of large windrows of yard waste that are turned by a turning machine. Turning the compost frequently (usually weekly) with the aid of a machine aerates the windrows and speeds up the rate of decomposition. The finished compost can be available in only four to six months. As many cities may have limited space to site a composting facility, moving the material through at a faster rate is an attractive feature.

Tree-Cycling

It is illegal for Missouri landfills to accept Christmas trees as well as yard wastes. There are two reasons for this mandate. First, these materials make up approximately 20 percent of the total solid waste destined for landfills. Secondly and equally important there are beneficial uses for these materials.

There are several environmentally sound methods for disposing of cut Christmas trees. Decorating your tree for wildlife can lengthen your enjoyment of the tree before final disposal. Building fish habitat and brush piles for wildlife are two other ways that trees may be used that benefit the environment. Finally, the tree may be chipped up with a chipping machine to use as landscaping mulch.

Poultry in Motion

Large, poultry-production operations in Missouri have found that disposing of dead poultry can be a big problem. As an example, a 100,000-bird operation that produces broilers may need to manage and dispose of up to 150 dead birds per day. While there are several alternatives for disposal such as on- site burial, on-site incineration or hauling to a sanitary landfill, all of these practices have environmental disadvantages. Burial can pose problems associated with water quality or pest infestation when burial pits are not properly maintained. Incineration is energy intensive and can cause air quality problems if the incinerator is not operated and maintained properly. Hauling to a landfill can become expensive if it is some distance from the operation. Also, landfill space is becoming more and more limited every day.

Dead poultry can be disposed of adequately in a properly designed and constructed composting facility. The end product can then be spread onto fields. The composted material does have some fertilizing qualities along with being a soil conditioner.

Sawdust Solutions

Sawmills in the state produce an estimated 760,000 tons of sawdust annually. The lack of good markets has forced many mills to stockpile large quantities of sawdust.
Recent concerns with potential impact of large, old piles on water quality have increased the pressure on mill owners to find markets for their stockpiled sawdust.

Old sawdust is difficult to market because it is non-uniform in size and often not suitable for animal bedding and fuel-pellet manufacturing.

Composting is an excellent method for processing old sawdust. Sawdust has a very high carbon to nitrogen (C:N) ratio. Composting sawdust with animal manures, materials that have high nitrogen content, is an effective means of overcoming problems associated with the high C:N ratio of fresh and aged sawdust.

A Fishy Situation

Missouri State Parks that have fish-cleaning stations are faced with disposing of the fish remains in a proper manner. Because fish remains, referred to as offal, are messy and smelly, the job of disposal can be a miserable one. Composting the fish remains with wood chips can make a useful product. The operational costs associated with disposal and environmental concerns are reduced as well. Overall, everyone benefits when fish remains are composted instead of landfilled.

The natural process of decomposition can be used for many different composting applications.

Kids and Compost

Stan Slaughter

Protecting our natural resources is a task we all must accomplish together. But before we can solve crucial environmental problems such as solid waste, we must be informed on the issues. It is important that all students have knowledge of the connection between themselves and the natural resources around them. This knowledge can be gained through educational activities that inform everyone about environmental issues.

Both formal and non- formal education can provide this knowledge on environmental issues. Stan Slaughter is an environmental-education consultant from Kansas City, Missouri. For the past five years, he has been using his experience as a classroom teacher to inform students and adults throughout the Midwest. By using his guitar and singing, Stan works to combine art and education in ways that stimulate his audience to discover more about the connection between people and the natural world.

Stan was awarded the 1995 **Environmental Educator of the Year** by the Missouri Sierra Club and U.S. Environmental Protection Agency Region 7 and **Missouri Environmental Educator of the Year** by the Missouri Waste Control Coalition in 1993.

Classroom Activity

Objectives

Students will gain an understanding that composting uses the natural recycling process of decomposition.

Method

Students construct a composting tower, record weekly observations and take measurements and summarize their findings.

Materials

Three, two-liter bottles to construct each three-piece compost tower; hot water; scissors and razor-blade knife; scotch tape; marking pens; pH paper; topsoil or potting soil; leaves; grass clippings; food scraps; bits of plastic; bits of aluminum foil; paper; data sheets and labels for each team.

Department photo by Nick Decker

Procedure

1. Divide the class into teams of three students each. Have each team construct a compost tower in the classroom using clear two-liter soda bottles. Follow assembly instructions at the end of this activity.

2. Place the soil in a plastic tub or bucket. Add water to slightly moisten the soil.

3. Fill the finished composting tower, alternating two-inch layers of soil and other items listed above. If you wish, you may have students weigh the soil and each item before placing it into the compost tower.

4. Add water to moisten all materials in the tower. Little or no water should drain from the tower at the beginning.

5. Make copies of the page with blank labels. Have each team label their com- post tower.

6. Have students make and record observations for at least four weeks using the data sheets provided.

Extension

Make a second tower. Add the same amounts of materials as in the first tower. Then add 25 earthworms. Compare the rates of decomposition between the two towers.

Evaluation

1. How are the materials broken down?

2. How long does it take for the organic materials to break down into the soil-like substance called humus?

3. What would happen if the organic materials did not break down?

Department file photo

Compost Tower Assembly Instructions

1. Fill two of the two-liter soda bottles with hot water and replace the cap. Allow to set for approximately two minutes. Heat from the water will melt the adhesives that attach the bottom to the clear plastic container and the label. Remove the label and twist off the bottom. Pour out and reuse the hot water to remove the labels and the bottoms from other bottles.

2. Refer to Figure 1 to determine where to cut the bottles.

3. Place the bottle on its side against the side of a box top. With a marker, make a ring where you want to make a cut. (Figure 2)

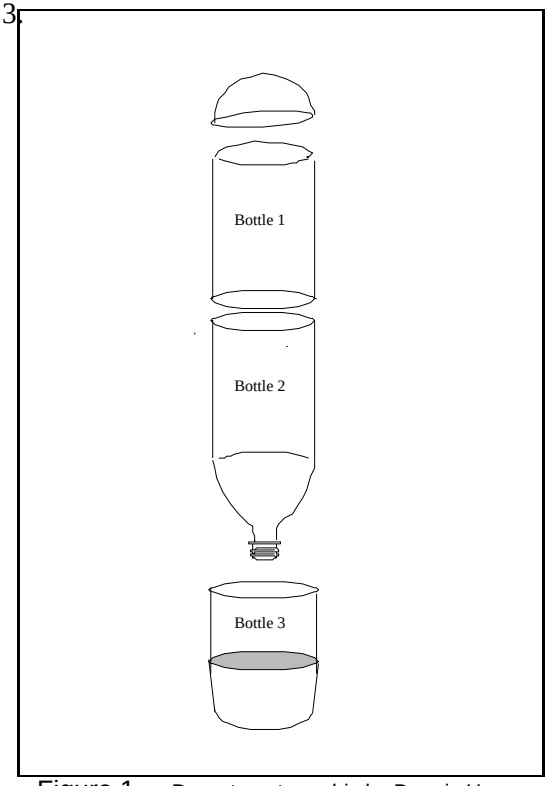


Figure 1 Department graphic by Dennis Hansen

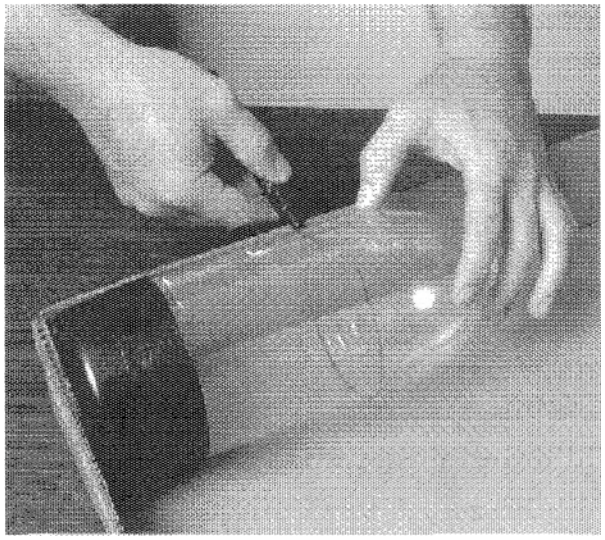


Figure 2 Department photo by Nick Decker

4. After marking the bottles, use a razor knife to start a cut and then finish cutting with scissors.

5. Put a piece of nylon stocking over the spout of bottle number 2 (Figure 1) and secure it with a rubber band.

6. Assemble the composting tower as shown in Figure I. Tape the seams.

7. Fill the composting tower as described in the procedure.

DATE: ____________________

TEAM MEMBERS:

____

____

____

CONTENTS:

1. ____________ wt.____gm.
2. ____________ wt.____gm.
3. ____________ wt.____gm.
4. ____________ wt.____gm.
5. ____________ wt.____gm.
6. ____________ wt.____gm.
7. ____________ wt.____gm.
8. ____________ wt.____gm.

total wt.____gm.

WATER ADDED: ____ ml.

DATE: ____________________

TEAM MEMBERS:

____

____

____

CONTENTS:

1. ____________ wt.____gm.
2. ____________ wt.____gm.
3. ____________ wt.____gm.
4. ____________ wt.____gm.
5. ____________ wt.____gm.
6. ____________ wt.____gm.
7. ____________ wt.____gm.
8. ____________ wt.____gm.

total wt.____gm.

WATER ADDED: ____ ml.

DATE: ____________________

TEAM MEMBERS:

____

____

____

CONTENTS:

1. ____________ wt.____gm.
2. ____________ wt.____gm.
3. ____________ wt.____gm.
4. ____________ wt.____gm.
5. ____________ wt.____gm.
6. ____________ wt.____gm.
7. ____________ wt.____gm.
8. ____________ wt.____gm.

total wt.____gm.

WATER ADDED: ____ ml.

DATE: ____________________

TEAM MEMBERS:

____

____

____

CONTENTS:

1. ____________ wt.____gm.
2. ____________ wt.____gm.
3. ____________ wt.____gm.
4. ____________ wt.____gm.
5. ____________ wt.____gm.
6. ____________ wt.____gm.
7. ____________ wt.____gm.
8. ____________ wt.____gm.

total wt.____gm.

WATER ADDED: ____ ml.

Compost Tower

Data Sheet

Team Members: _____

Time Period	Material Texture	Material Height	Other Observations*
Week 1			
Week 2			
Week 3			
Week 4			
Week 5			
Week 6			

* Other observations may include: pH, temperature, amount of water added.

Vocabulary

1. ***Agronomist*** - a professional trained in the science and economics of crop production and the management of farm land.

2. ***Amino acids*** - molecules containing nitrogen that are the basic building blocks of proteins.

3. ***Cell nucleus*** - the membrane-bound region in a cell that contains the cell's deoxyribo nucleic acid (DNA).

4. ***Decomposition*** - the break down of non-living organic materials into basic components or parts.

5. ***Ecosystem*** - a community of organisms along with all associated living and non-living factors that maintain a stable system.

6. ***Fungi*** - heterotrophic organisms such as mushrooms and mold that feed on dead or decaying organic material resulting in decomposition.

7. ***Humus*** - the organic, usually uppermost, layer of soil.

8. ***Photosynthesis*** - the conversion of sunlight into chemical energy by green plants and some microorganisms.

9. ***Proteins*** - molecules composed of chains of amino acids.

10. ***Respiration*** - the exchange of oxygen and carbon dioxide between cells and the environment.

This video is available on the department's Web site at www.dnr.mo.gov/videos/index.html.

For additional copies of this publication, visit www.dnr.mo.gov/pubs/pub697.pdf.

References

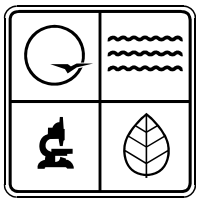
Compost Learning Guide. Stan Slaughter. 1994. The Composter's Project, an educational project of Heartland All Species Project, 201 Westport Rd., Kansas City, MO.

Composting Poultry Carcasses in Missouri. Charles Fulhage, University Extension, University of Missouri-Columbia. 2800 MaGuire Bldg., Columbia, MO.

Homeowner's Composting Guide: How to Manage Yard Waste **PUB183**. Missouri Environmental Improvement and Energy Resources Authority and Missouri Department of Natural Resources. P.O. Box 176, Jefferson City, MO. www.dnr.mo.gov/env/swmp/composting/compost1.htm

Christmas Tree Disposal **PUB184**. Missouri Department of Natural Resources. P.O. Box 176, Jefferson City, MO. www.dnr.mo.gov/pubs/pub184.pdf

For more information about composting or design sheets for composting bins and worm bins, contact the Missouri Department of Natural Resources, Solid Waste Management Program, P.O. Box 176, Jefferson City, MO 65102. Phone: (573) 751-5401 toll-free 1-800-361-4827



Missouri Department of Natural Resources
Solid Waste Management Program
P.O. Box 176
Jefferson City, MO 65102-0176

Phone:
(573) 751-5401
toll-free
1-800-361-4827